

No.

8900174



THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME;

Pioneer Hi-Bred International, Inc.

Whereas, THERE HAS BEEN PRESENTED TO THE

Secretary of Agriculture

AN APPLICATION REQUESTING A CERTIFICATE OF PROTECTION FOR AN ALLEGED NOVEL VARIETY OF SEXUALLY REPRODUCED PLANT, THE NAME AND DESCRIPTION OF WHICH ARE CONTAINED IN THE APPLICATION AND EXHIBITS, A COPY OF WHICH IS HEREUNTO ANNEXED AND MADE A PART HEREOF, AND THE VARIOUS REQUIREMENTS OF LAW IN SUCH CASES MADE AND PROVIDED HAVE BEEN COMPLIED WITH, AND THE TITLE THERETO IS, FROM THE RECORDS OF THE PLANT VARIETY PROTECTION OFFICE, IN THE APPLICANT(S) INDICATED IN THE SAID COPY, AND WHEREAS, UPON DUE EXAMINATION MADE, THE SAID APPLICANT(S) IS (ARE) ADJUDGED TO BE ENTITLED TO A CERTIFICATE OF PLANT VARIETY PROTECTION UNDER THE LAW.

NOW, THEREFORE, THIS CERTIFICATE OF PLANT VARIETY PROTECTION IS TO GRANT UNTO THE SAID APPLICANT(S) AND THE SUCCESSORS, HEIRS OR ASSIGNS OF THE SAID APPLICANT(S) FOR THE TERM OF *eighteen* YEARS FROM THE DATE OF THIS GRANT, SUBJECT TO THE PAYMENT OF THE REQUIRED FEES AND PERIODIC REPLENISHMENT OF VIABLE BASIC SEED OF THE VARIETY IN A PUBLIC REPOSITORY AS PROVIDED BY LAW, THE RIGHT TO EXCLUDE OTHERS FROM SELLING THE VARIETY, OR OFFERING IT FOR SALE, OR REPRODUCING IT, OR IMPORTING IT, OR EXPORTING IT, OR USING IT IN PRODUCING A HYBRID OR DIFFERENT VARIETY THEREFROM, TO THE EXTENT PROVIDED BY THE PLANT VARIETY PROTECTION ACT OF 1930, AS AMENDED, 7 U.S.C. 2321 ET SEQ.)

SOYBEAN

'9303'



In Testimony Whereof, I have hereunto set my hand and caused the seal of the Plant Variety Protection Office to be affixed at the City of Washington, D. C. this 31st day of December in the year of our Lord one thousand nine hundred and ninety.

Attest:

Kenneth A. Evans

Commissioner

Plant Variety Protection Office
Agricultural Marketing Service

Clayton Fentler
Secretary of Agriculture

U.S. DEPARTMENT OF AGRICULTURE
AGRICULTURAL MARKETING SERVICE

FORM APPROVED: OMB NO. 0581-0055

APPLICATION FOR PLANT VARIETY PROTECTION CERTIFICATE

(Instructions on reverse)

Application is required in order to determine if a plant variety protection certificate is to be issued (7 U.S.C. 2421). Information is held confidential until certificate is issued (7 U.S.C. 2426).

1. NAME OF APPLICANT(S) Pioneer Hi-Bred International, Inc.		2. TEMPORARY DESIGNATION	3. VARIETY NAME 9303
4. ADDRESS (Street and No. or R.F.D. No., City, State, and Zip Code) 700 Capital Square 400 Locust Street Des Moines, IA 50309		5. PHONE (Include area code) 319-234-0335	FOR OFFICIAL USE ONLY PVPO NUMBER 8900174
6. GENUS AND SPECIES NAME Glycine Max	7. FAMILY NAME (Botanical) Leguminosae		FILING DATE Apr. 17, 1989 TIME <input type="checkbox"/> A.M. <input type="checkbox"/> P.M.
8. KIND NAME Soybean	9. DATE OF DETERMINATION October, 1983 January, 1987 (increase)		FEES RECEIVED AMOUNT FOR FILING \$ 1800.00 DATE Apr. 17, 1989 AMOUNT FOR CERTIFICATE \$ 200.00 DATE Dec. 11, 1990
10. IF THE APPLICANT NAMED IS NOT A "PERSON," GIVE FORM OF ORGANIZATION (Corporation, partnership, association, etc.) Corporation			12. DATE OF INCORPORATION 1926
11. IF INCORPORATED, GIVE STATE OF INCORPORATION Iowa			
13. NAME AND ADDRESS OF APPLICANT REPRESENTATIVE(S), IF ANY, TO SERVE IN THIS APPLICATION AND RECEIVE ALL PAPERS Clark W. Jennings 3261 West Airline Highway Waterloo, IA 50703-9610 Mary Helen Mitchell (copy) 700 Capital Square - 400 Locust Street Des Moines, IA 50309 PHONE (Include area code):			
14. CHECK APPROPRIATE BOX FOR EACH ATTACHMENT SUBMITTED a. <input checked="" type="checkbox"/> Exhibit A, Origin and Breeding History of the Variety (See Section 52 of the Plant Variety Protection Act.) b. <input checked="" type="checkbox"/> Exhibit B, Novelty Statement. c. <input checked="" type="checkbox"/> Exhibit C, Objective Description of Variety (Request form from Plant Variety Protection Office.) d. <input type="checkbox"/> Exhibit D, Additional Description of Variety. e. <input checked="" type="checkbox"/> Exhibit E, Statement of the Basis of Applicant's Ownership.			
15. DOES THE APPLICANT(S) SPECIFY THAT SEED OF THIS VARIETY BE SOLD BY VARIETY NAME ONLY AS A CLASS OF CERTIFIED SEED? (See Section 83(a) of the Plant Variety Protection Act.) <input type="checkbox"/> Yes (If "Yes," answer items 16 and 17 below) <input checked="" type="checkbox"/> No			
16. DOES THE APPLICANT(S) SPECIFY THAT THIS VARIETY BE LIMITED AS TO NUMBER OF GENERATIONS? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No		17. IF "YES" TO ITEM 16, WHICH CLASSES OF PRODUCTION BEYOND BREEDER SEED? <input type="checkbox"/> Foundation <input type="checkbox"/> Registered <input type="checkbox"/> Certified	
18. DID THE APPLICANT(S) PREVIOUSLY FILE FOR PROTECTION OF THE VARIETY IN THE U.S.? <input type="checkbox"/> Yes (If "Yes," give date) <input checked="" type="checkbox"/> No			
19. HAS THE VARIETY BEEN RELEASED, OFFERED FOR SALE, OR MARKETING IN THE U.S. OR OTHER COUNTRIES? <input type="checkbox"/> Yes (If "Yes," give names of countries and dates) <input checked="" type="checkbox"/> No			
20. The applicant(s) declare(s) that a viable sample of basic seeds of this variety will be furnished with the application and will be replenished upon request in accordance with such regulations as may be applicable. The undersigned applicant(s) is (are) the owner(s) of this sexually reproduced novel plant variety, and believe(s) that the variety is distinct, uniform, and stable as required in Section 41, and is entitled to protection under the provisions of Section 42 of the Plant Variety Protection Act. Applicant(s) is (are) informed that false representation herein can jeopardize protection and result in penalties.			
SIGNATURE OF APPLICANT Clark Jennings		DATE April 6, 1989	
SIGNATURE OF APPLICANT		DATE	

Attachment: 9303 Soybean (April, 1989)

Exhibit A: Variety 9303 evolved from a cross between Variety 2981 X CM385. It is a F5-derived variety which was advanced to the F5 generation by modified single-seed descent. The F6 progeny row of 9303 was grown in Ohio during the summer of 1983. Subsequently, 9303 has undergone five years of extensive testing and purification and has been observed by the breeder to be uniform and stable for all plant traits from generation to generation with no evidence of variants.

Six acres of 9303 (breeder's seed) were grown in 1987. 75 acres of parent seedstock (foundation seed equivalent) were grown in 1988.

Exhibit B: 9303 is most similar to the Variety S2920, Variety Taylor and Variety Oak. However, 9303 is 3.25 days later maturing than S2920 (121.38 days vs. 118.13 days, TABLE 1). 9303 has low peroxidase activity whereas S2920 has high peroxidase activity. The maximum canopy width at the R5 stage of 9303 is 3.38 inches wider than that for S2920 (27.94 vs. 24.56 inches TABLE 2).

9303 differs from Taylor in that 9303 is 3.94 days later maturing than Taylor (121.38 vs. 117.44 days, TABLE 3). 9303 has larger seeds than Taylor (20.1 vs. 15.8 grams/100 seeds, TABLE 4). Also, the maximum canopy width at R5 stage of 9303 is 2.69 inches wider than that for Taylor (27.94 vs. 25.25 inches, TABLE 5).

9303 differs from Oak in that 9303 is 5.0 days later maturing than Oak (121.38 vs. 116.38 days, TABLE 6). 9303 has larger seeds than Oak (20.13 vs. 18.66 grams/100 seeds, TABLE 7). Also, the maximum canopy width at R5 stage of 9303 is 3.94 inches wider than that for Oak (27.94 vs. 24.00 inches, TABLE 8).

Exhibit E: Pioneer Hi-Bred International, Inc. is the sole, original, and first breeder of soybean variety 9303, for which it solicits a certificate of protection.

U.S. DEPARTMENT OF AGRICULTURE
 AGRICULTURAL MARKETING SERVICE
 LIVESTOCK, MEAT, GRAIN & SEED DIVISION
 PLANT VARIETY PROTECTION OFFICE
 BELTSVILLE, MARYLAND 20705

EXHIBIT C
 (Soybean)

OBJECTIVE DESCRIPTION OF VARIETY
 SOYBEAN (*Glycine max* L.)

NAME OF APPLICANT(S) Pioneer Hi-Bred International, Inc.	TEMPORARY DESIGNATION	VARIETY NAME 9303
ADDRESS (Street and No., or R.F.D. No., City, State, and Zip Code) 700 Capital Square 400 Locust Street Des Moines, IA 50309		FOR OFFICIAL USE ONLY PVPO NUMBER 8900174

Choose the appropriate response which characterizes the variety in the features described below. When the number of significant digits in your answer is fewer than the number of boxes provided, place a zero in the first box when number is 9 or less (e.g.,).

1. SEED SHAPE:



1 = Spherical (L/W, L/T, and T/W ratios = ≤ 1.2)
 3 = Elongate (L/T ratio > 1.2 ; T/W = ≤ 1.2)

2 = Spherical Flattened (L/W ratio > 1.2 ; L/T ratio = ≤ 1.2)
 4 = Elongate Flattened (L/T ratio > 1.2 ; T/W > 1.2)

2. SEED COAT COLOR: (Mature Seed)

1 = Yellow 2 = Green 3 = Brown 4 = Black 5 = Other (Specify) _____

3. SEED COAT LUSTER: (Mature Hand Shelled Seed)

1 = Dull ('Corsoy 79'; 'Braxton') 2 = Shiny ('Nebsoy'; 'Gasoy 17')

4. SEED SIZE: (Mature Seed)

Grams per 100 seeds

5. HILUM COLOR: (Mature Seed)

1 = Buff 2 = Yellow 3 = Brown 4 = Gray 5 = Imperfect Black 6 = Black 7 = Other (Specify) _____

6. COTYLEDON COLOR: (Mature Seed)

1 = Yellow 2 = Green

7. SEED PROTEIN PEROXIDASE ACTIVITY:

1 = Low 2 = High

8. SEED PROTEIN ELECTROPHORETIC BAND:

1 = Type A (SP1^a) 2 = Type B (SP1^b)

9. HYPOCOTYL COLOR:

1 = Green only ('Evans'; 'Davis') 2 = Green with bronze band below cotyledons ('Woodworth'; 'Tracy')
 3 = Light Purple below cotyledons ('Beeson'; 'Pickett 71')
 4 = Dark Purple extending to unifoliate leaves ('Hodgson'; 'Coker Hampton 266A')

10. LEAFLET SHAPE:

1 = Lanceolate 2 = Oval 3 = Ovate 4 = Other (Specify) _____

11. LEAFLET SIZE:

☐ 21 = Small ('Amsoy 71'; 'A5312')
3 = Large ('Crawford'; 'Tracy')

2 = Medium ('Corsoy 79'; 'Gasoy 17')

12. LEAF COLOR:

☐ 21 = Light Green ('Weber'; 'York')
3 = Dark Green ('Gnome'; 'Tracy')

2 = Medium Green ('Corsoy 79'; 'Braxton')

13. FLOWER COLOR:

☐ 2

1 = White

2 = Purple

3 = White with purple throat

14. POD COLOR:

☐ 2

1 = Tan

2 = Brown

3 = Black

15. PLANT PUBESCENCE COLOR:

☐ 1

1 = Gray

2 = Brown (Tawny)

16. PLANT TYPES:

☐ 21 = Slender ('Essex'; 'Amsoy 71')
3 = Bushy ('Gnome'; 'Govan')

2 = Intermediate ('Amcor'; 'Braxton')

17. PLANT HABIT:

☐ 3

1 = Determinate ('Gnome'; 'Braxton')

2 = Semi-Determinate ('Will')

3 = Indeterminate ('Nebsoy'; 'Improved Pelican')

18. MATURITY GROUP:

☐ 0 ☐ 6

1 = 000

2 = 00

3 = 0

4 = I

5 = II

6 = III

7 = IV

8 = V

9 = VI

10 = VII

11 = VIII

12 = IX

13 = X

19. DISEASE REACTION: (Enter 0 = Not Tested; 1 = Susceptible; 2 = Resistant)

BACTERIAL DISEASES:

☐ 0Bacterial Pustule (*Xanthomonas phaseoli* var. *sojensis*)☐ 0Bacterial Blight (*Pseudomonas glycinea*)☐ 0Wildfire (*Pseudomonas tabaci*)

FUNGAL DISEASES:

☐ 0Brown Spot (*Septoria glycines*)Frogeye Leaf Spot (*Cercospora sojae*)☐ 0

Race 1

☐ 0

Race 2

☐ 0

Race 3

☐ 0

Race 4

☐ 0

Race 5

☐

Other (Specify)

☐ 0Target Spot (*Corynespora cassiicola*)☐ 0Downy Mildew (*Peronospora trifoliorum* var. *manshurica*)☐ 0Powdery Mildew (*Microsphaera diffusa*)☐ 0Brown Stem Rot (*Cephalosporium gregatum*)☐ 0Stem Canker (*Diaporthe phaseolorum* var. *caulivora*)

19. DISEASE REACTION: (Enter 0 = Not Tested; 1 = Susceptible; 2 = Resistant) (Continued)

FUNGAL DISEASES: (Continued)

<input type="checkbox"/> 0	Pod and Stem Blight (<i>Diaporthe phaseolorum</i> var; <i>sojae</i>)												
<input type="checkbox"/> 0	Purple Seed Stain (<i>Cercospora kikuchii</i>)												
<input type="checkbox"/> 0	Rhizoctonia Root Rot (<i>Rhizoctonia solani</i>)												
Phytophthora Rot (<i>Phytophthora megasperma</i> var. <i>sojae</i>)													
<input type="checkbox"/> 1	Race 1	<input type="checkbox"/> 1	Race 2	<input type="checkbox"/> 1	Race 3	<input type="checkbox"/> 1	Race 4	<input type="checkbox"/> 1	Race 5	<input type="checkbox"/> 1	Race 6	<input type="checkbox"/> 1	Race 7
<input type="checkbox"/> 1	Race 8	<input type="checkbox"/> 1	Race 9	<input type="checkbox"/>	Other (Specify) _____								

VIRAL DISEASES:

<input type="checkbox"/> 0	Bud Blight (Tobacco Ringspot Virus)
<input type="checkbox"/> 0	Yellow Mosaic (Bean Yellow Mosaic Virus)
<input type="checkbox"/> 0	Cowpea Mosaic (Cowpea Chlorotic Virus)
<input type="checkbox"/> 0	Pod Mottle (Bean Pod Mottle Virus)
<input type="checkbox"/> 0	Seed Mottle (Soybean Mosaic Virus)

NEMATODE DISEASES:

Soybean Cyst Nematode (<i>Heterodera glycines</i>)											
<input type="checkbox"/> 1	Race 1	<input type="checkbox"/> 1	Race 2	<input type="checkbox"/> 1	Race 3	<input type="checkbox"/> 1	Race 4	<input type="checkbox"/>	Other (Specify) _____		
<input type="checkbox"/> 1	Lance Nematode (<i>Hoplolaimus Colombus</i>)										
<input type="checkbox"/> 1	Southern Root Knot Nematode (<i>Meloidogyne incognita</i>)										
<input type="checkbox"/> 1	Northern Root Knot Nematode (<i>Meloidogyne Hapla</i>)										
<input type="checkbox"/> 1	Peanut Root Knot Nematode (<i>Meloidogyne arenaria</i>)										
<input type="checkbox"/> 1	Reniform Nematode (<i>Rotylenchulus reniformis</i>)										
<input type="checkbox"/> 1	OTHER DISEASE NOT ON FORM (Specify): _____										

20. PHYSIOLOGICAL RESPONSES: (Enter 0 = Not Tested; 1 = Susceptible; 2 = Resistant)

<input type="checkbox"/> 1	Iron Chlorosis on Calcareous Soil
<input type="checkbox"/>	Other (Specify) _____

21. INSECT REACTION: (Enter 0 = Not Tested; 1 = Susceptible; 2 = Resistant)

<input type="checkbox"/> 0	Mexican Bean Beetle (<i>Epilachna varivestis</i>)
<input type="checkbox"/> 0	Potato Leaf Hopper (<i>Empoasca fabae</i>)
<input type="checkbox"/>	Other (Specify) _____

22. INDICATE WHICH VARIETY MOST CLOSELY RESEMBLES THAT SUBMITTED.

CHARACTER	NAME OF VARIETY	CHARACTER	NAME OF VARIETY
Plant Shape	Taylor	Seed Coat Luster	Taylor
Leaf Shape	Taylor	Seed Size	Taylor
Leaf Color	Taylor	Seed Shape	Taylor
Leaf Size	Taylor	Seedling Pigmentation	Taylor

23. GIVE DATA FOR SUBMITTED AND SIMILAR STANDARD VARIETY: Paired Comparison Data

VARIETY	NO. OF DAYS MATURITY	PLANT LODGING SCORE	CM PLANT HEIGHT	LEAFLET SIZE		SEED CONTENT		SEED SIZE G/100 SEEDS	NO. SEEDS/POD
				CM Width	CM Length	% Protein	% Oil		
9303 Submitted	121	1.9	99.1					20.1	
Taylor Name of Similar Variety	117	2.8	98.6					15.8	

PUBLICATIONS USEFUL AS REFERENCE AIDS FOR COMPLETING THIS FORM:

1. Caldwell, B.E., ed. 1973. Soybeans: Improvement, Production, and Uses. Amer. Soc. Agron. Monograph No. 16.
2. Buttery, B.R. and R.I. Buzzell. 1968. Peroxidase activity in seeds of soybean varieties. Crop Sci., 8: 722-725.
3. Hymowitz, T. 1973. Electrophoretic analysis of SBT1-A₂ in the USDA soybean germplasm collection. Crop Sci., 13: 420-421.
4. Payne, R.C. and L.F. Morris. 1976. Differentiation of soybean cultivars by seedling pigmentation patterns. J. Seed Technol. 1: 1-19.

Table 1. Paired Comparison (days to maturity) Data

REP	9303(X_1)	S2920(X_2)	($X_1 - X_2$)	($X_1 - X_2$) ²
1	121	119	2	4
2	121	118	3	9
3	120	118	2	4
4	121	119	2	4
5	121	115	6	36
6	120	117	3	9
7	123	119	4	16
8	122	118	4	16
9	123	118	5	25
10	122	118	4	16
11	121	117	4	16
12	122	119	3	9
13	120	119	1	1
14	121	118	3	9
15	122	120	2	4
16	122	118	4	16
TOTAL	1942	1890	52	194
\bar{X}	121.38	118.13	3.25	12.13

N = 16

$$s_d = \sqrt{\frac{194 - [(52)^2/16]}{16(15)}} = 0.323$$

$$t = \frac{3.25}{0.323} = 10.06 \text{ ** for 15 df}$$

Table 2. Paired Comparison (canopy width) Data

REP	9303(X_1)	S2920(X_2)	($X_1 - X_2$)	($X_1 - X_2$) ²
1	27	24	3	9
2	28	25	3	9
3	27	25	2	4
4	27	22	5	25
5	28	24	4	16
6	29	27	2	4
7	28	25	3	9
8	28	25	3	9
9	28	24	4	16
10	28	24	4	16
11	26	24	2	4
12	29	24	5	25
13	29	24	5	25
14	27	26	1	1
15	29	25	4	16
16	29	25	4	16
TOTAL	447	393	54	204
\bar{X}	27.94	24.56	3.38	12.75

N = 16

$$s_d = \sqrt{\frac{204 - [(54)^2/16]}{16(15)}} = 0.301$$

$$t = \frac{3.38}{0.301} = 11.23 \text{ ** for 15 df}$$

Table 3. Paired Comparison (days to maturity) Data

REP	9303(X_1)	TAYLOR(X_2)	($X_1 - X_2$)	($X_1 - X_2$) ²
1	121	117	4	16
2	121	118	3	9
3	120	117	3	9
4	121	117	4	16
5	121	118	3	9
6	120	119	1	1
7	123	116	7	49
8	122	117	5	25
9	123	117	6	36
10	122	118	4	16
11	121	118	3	9
12	122	117	5	25
13	120	118	2	4
14	121	117	4	16
15	122	117	5	25
16	122	118	4	16
TOTAL	1942	1879	63	281
\bar{X}	121.38	117.44	3.94	17.56

N = 16

$$s_d = \sqrt{\frac{281 - [(63)^2/16]}{16(15)}} = 0.37$$

$$t = \frac{3.94}{0.37} = 10.65 \text{ ** for 15 df}$$

Table 4. Paired Comparison (grams/100 seeds) Data

REP	9303(X_1)	TAYLOR(X_2)	($X_1 - X_2$)	($X_1 - X_2$) ²
1	19.5	15.5	4.0	16.00
2	19.5	15.0	4.5	20.25
3	20.5	16.0	4.5	20.25
4	20.0	15.5	4.5	20.25
5	19.5	15.5	4.0	16.00
6	20.5	15.5	5.0	25.00
7	20.0	17.0	3.0	9.00
8	20.0	15.5	4.5	20.25
9	19.0	16.0	3.0	9.00
10	20.0	16.0	4.0	16.00
11	21.0	15.5	5.5	30.25
12	20.0	16.5	3.5	12.25
13	20.0	16.0	4.0	16.00
14	21.0	15.5	5.5	30.25
15	21.0	15.5	5.5	30.25
16	20.5	16.0	4.5	20.25
TOTAL	322.0	252.5	69.5	311.25
\bar{X}	20.13	15.78	4.34	19.45

N = 16

$$s_d = \sqrt{\frac{311.25 - [(69.5)^2/16]}{16(15)}} = 0.197$$

$$t = \frac{4.34}{0.197} = 22.08 ** \text{ for 15 df}$$

8900174

Table 5. Paired Comparison (canopy width) Data

REP	9303(X_1)	TAYLOR(X_2)	($X_1 - X_2$)	($X_1 - X_2$) ²
1	27	24	3	9
2	28	21	7	49
3	27	26	1	1
4	27	26	1	1
5	28	24	4	16
6	29	26	3	9
7	28	25	3	9
8	28	26	2	4
9	28	27	1	1
10	28	24	4	16
11	26	24	2	4
12	29	27	2	4
13	29	27	2	4
14	27	25	2	4
15	29	26	3	9
16	29	26	3	9
TOTAL	447	404	43	149
\bar{X}	27.94	25.25	2.69	9.31

N = 16

$$s_d = \sqrt{\frac{149 - [(43)^2/16]}{16(15)}} = 0.373$$

$$t = \frac{2.69}{0.373} = 7.21^{**} \text{ for 15 df}$$

Table 6. Paired Comparison (days to maturity) Data

REP	9303(X_1)	OAK(X_2)	($X_1 - X_2$)	($X_1 - X_2$) ²
1	121	117	4	16
2	121	116	5	25
3	120	116	4	16
4	121	117	4	16
5	121	116	5	25
6	120	116	4	16
7	123	116	7	49
8	122	117	5	25
9	123	117	6	36
10	122	116	6	36
11	121	116	5	25
12	122	117	5	25
13	120	117	3	9
14	121	116	5	25
15	122	116	6	36
16	122	116	6	36
TOTAL	1942	1862	80	416
\bar{X}	121.38	116.38	5	26

N = 16

$$s_d = \sqrt{\frac{416 - [(80)^2/16]}{16(15)}} = 0.258$$

$$t = \frac{5}{0.258} = 19.38 \text{ ** for 15 df}$$

Table 7. Paired Comparison (grams/100 seeds) Data

REP	9303(X_1)	OAK(X_2)	($X_1 - X_2$)	($X_1 - X_2$) ²
1	19.5	18.5	1.0	1.00
2	19.5	19.0	0.5	0.25
3	20.5	19.0	1.5	2.25
4	20.0	19.0	1.0	1.00
5	19.5	18.5	1.0	1.00
6	20.5	18.5	2.0	4.00
7	20.0	19.0	1.0	1.00
8	20.0	19.0	1.0	1.00
9	19.0	18.5	0.5	0.25
10	20.0	19.0	1.0	1.00
11	21.0	19.0	2.0	4.00
12	20.0	17.5	2.5	6.25
13	20.0	18.0	2.0	4.00
14	21.0	19.0	2.0	4.00
15	21.0	18.5	2.5	6.25
16	20.5	18.5	2.0	4.00
TOTAL	322.0	298.5	23.5	41.25
\bar{X}	20.13	18.66	1.47	2.58

N = 16

$$s_d = \sqrt{\frac{41.25 - [(23.5)^2/16]}{16(15)}} = 0.167$$

$$t = \frac{1.47}{0.167} = 8.80 \text{ ** for 15 df}$$

Table 8. Paired Comparison (canopy width) Data

REP	9303(X_1)	OAK(X_2)	($X_1 - X_2$)	($X_1 - X_2$) ²
1	27	25	2	4
2	28	23	5	25
3	27	24	3	9
4	27	24	3	9
5	28	22	6	36
6	29	27	2	4
7	28	22	6	36
8	28	25	3	9
9	28	24	4	16
10	28	23	5	25
11	26	24	2	4
12	29	24	5	25
13	29	26	3	9
14	27	24	3	9
15	29	22	7	49
16	29	25	4	16
TOTAL	447	384	63	285
\bar{X}	27.94	24	3.94	17.81

N = 16

$$s_d = \sqrt{\frac{285 - [(63)^2/16]}{16(15)}} = 0.392$$

$$t = \frac{3.94}{0.392} = 10.05 ** \text{ for 15 df}$$